Tetra Tech, Inc.
Quality Management Plan

Prepared for:

Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum

Revision 0
October 2016

TETRA TECH

Tetra Tech, Inc.
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Parsippany, New Jersey 07054

REVISION RECORD

Revisions to this document will be reviewed and approved through the same level of authority as the original document. All changes to the Quality Management Plan (QMP) must be authorized by the Director of Quality Programs.

Revision	Date	Pages Affected	Reason	Authorized By
Revision 0	13 October 2016	Multiple	Project-specific revisions to Quality Practices Manual	W. Brownlie

CONTENTS

FIGURES

ACRONYMS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASQ	American Society for Quality
CA	Construction Administration
CEO	Chief Executive Officer
CM	Construction Management
CQA	Construction Quality Assurance
CQC	Construction Quality Control
CQM	Construction Quality Management
ECN	Engineering Change Notice
EDD	Electronic Data Deliverable
EPA	US Environmental Protection Agency
GSH	Glenn Springs Holdings, Inc.
IT	Information Technology
ISO	International Organization for Standardization
O&M	Operations and Maintenance
Oxy	Occidental Chemical Corporation
OU	Operable Unit
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
QMS	Quality Management System
RFI	Requests for Information
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SOW	Scope of Work

DEFINITIONS

Quality
Conformance of the features and characteristics of the products or services provided by Tetra Tech to the stated or implied needs and expectations of our internal requirements and external clients and projects.

Quality Lead
Assigned Tetra Tech quality leader for a project, responsible for confirming that applicable quality assurance/quality control requirements have been applied. Sometimes referred to as Quality Manager, QA Manager, OA Officer, or other terms that may be specific to a program, project, or client requirements.

Quality Policy
The overall intentions and direction of Tetra Tech related to quality as formally expressed by upper management and documented in this manual.

Quality Management System
Tetra Tech's set of interacting practices and associated organizational structure established for planning and executing services that meet the quality requirements of our clients.

Quality Assurance
The application of systematic activities within the Quality Management System that provides confidence that quality requirements will be fulfilled.

Quality Control
The implementation of operational techniques and activities at the project level to confirm Tetra Tech's and our clients' requirements for quality are fulfilled.

Note: The definitions provided above are adapted for use by Tetra Tech from ISO 9000, Second Edition 2000-12-15, *Quality Management Systems—Fundamentals and Vocabulary*.

FOREWORD

This Tetra Tech, Inc. (Tetra Tech) Quality Management Plan (QMP) describes Tetra Tech's quality program policy and requirements to be implemented during the performance of our investigation, engineering, remediation, and program support services. The purpose of the QMP is to define basic quality assurance / quality control (QA/QC) requirements that will guide, as applicable, Tetra Tech personnel during planning, implementation, work product preparation, and field activities. This document specifically addresses how Tetra Tech's quality program will be applied to the project entitled "Operable Unit Two (OU2) of the Diamond Alkali Superfund Site, in and about Essex, Hudson, Bergen and Passaic Counties, New Jersey," (the "Project") to be conducted for Glenn Springs Holdings, Inc. (GSH), a subsidiary to Occidental Petroleum Corporation (Oxy), Houston, Texas.

The QMP describes:

1. **The Tetra Tech quality program organization**, including the roles and responsibilities of Tetra Tech in implementing this QMP;
2. **Basic Quality Management System (QMS) requirements** to be addressed; and
3. **Basic QA and QC requirements** applicable to data collection, work product preparation, engineering design, construction services, and technical support.

This QMP addresses quality requirements from a program/project management perspective, providing managers with QA/QC requirements needed to plan, implement, and assess environmental programs. It identifies a set of fundamental requirements commensurate with the scope, nature, and complexity of environmental activities. Environmental activities covered by this QMP include environmental studies, investigations, feasibility studies, records of decision, project planning, remedial design, remediation testing, remedial and removal actions, and site cleanup verification activities. Additional details and specific quality requirements not completely covered by this QMP will be included in the project-specific US Environmental Protection Agency (EPA) approved, Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP).

Tetra Tech prepared this QMP in accordance with EPA/240/B-01/002, *EPA Requirements for Quality Management Plans (QA/R-2)*. Consensus standard American National Standards Institute/American Society for Quality (ANSI/ASQ) E4-2004, *Quality Management Systems for Environmental Data and Technology Programs*, provided the basis for the quality standards related to environmental programs addressed in this QMP. We are currently in the process of reviewing and updating, as necessary, our quality systems for compliance with the most recent version of ANSI/ASQ E4 (February 2014). The Tetra Tech quality program is also modeled after the quality management principles outlined in the International Organization for Standardization (ISO) 9000 guidance document. The effective implementation of the QA/QC requirements of this QMP, coupled with specific plans such as quality assurance project plans (QAPPs), will ensure the quality of our environmental and engineering programs.

TETRA TECH QUALITY MANAGEMENT PRINCIPLES

ISO 9000 provides guidance on the fundamentals and vocabulary that can be used as the basis for developing Quality Management Systems (QMSs). The ISO guidance includes eight quality management principles that Tetra Tech subscribes to and that serve as the basic principles of our QMS. As indicated in the ISO 9000 guidance (p. v):

> *To lead and operate an organization successfully, it is necessary to direct and control it in a systematic and transparent manner. Success can result from implementing and maintaining a management system that is designed to continually improve performance while addressing the needs of all interested parties. Managing an organization encompasses quality management amongst other management disciplines.*

The following eight quality management principles adopted by Tetra Tech shall be used by upper management to lead our organization towards improved performance.

1. **Client focus**: Tetra Tech depends on its clients and must understand current and future client needs, meet our client requirements, and strive to exceed client expectations.
2. **Leadership**: It is the responsibility of the senior management of Tetra Tech to establish unity of purpose and direction of the organization. They must create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.
3. **Involvement of people**: Tetra Tech associates at all levels are the essence of our organization and their full involvement enables their abilities to be used for the benefit of Tetra Tech and our clients.
4. **Process approach**: A desired result is achieved more efficiently when Tetra Tech activities and resources are managed as a process.
5. **System approach to management**: Identifying, understanding, and managing interrelated processes as a system contributes to Tetra Tech's effectiveness and efficiency in achieving its objectives.
6. **Continuous improvement**: Continuous improvement of Tetra Tech's overall performance is a permanent objective of our organization.
7. **Factual approach to decision making**: Tetra Tech recognizes that effective decisions are based on the analysis of data and information.
8. **Mutually beneficial supplier relationships**: Tetra Tech and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

These eight principles form the basis for the QMS standards implemented by Tetra Tech and are consistent with guidance within the ISO 9000 family.

TETRA TECH COMMITMENT TO QUALITY

The employees of Tetra Tech are dedicated to providing our clients with a quality advantage through a continuous process of quality advancement in all areas of our performance. Specifically, our Quality Policy is as follows:

> Tetra Tech is a world-class provider of professional services in the practice of consulting, engineering, remediation, and construction services. Our goal is to meet or exceed the expectations of our clients. We accomplish this in an environment that nurtures employee pride and satisfaction and leads to continuing growth and prosperity. We demonstrate our commitment to quality through continuous process improvement, through training, and by ensuring each of our team members recognizes the value of high quality products.

Commitment to quality begins at the CEO of Tetra Tech, the highest management level of Tetra Tech and is passed down to every level of the organization. In essence, a commitment is expected and required from all employees. This focus on quality by our entire organization has enabled Tetra Tech to deliver quality service in the past and will allow us to continue to do so in the future.

TETRA TECH QUALITY POLICY

Tetra Tech will continue to grow as a company by offering innovative and cost-effective solutions to complex world problems and consistently satisfying the needs of our clients. Tetra Tech works with its clients and suppliers in the early stages of each program and project to identify client needs and expectations and to establish agreed-upon quality requirements. Tetra Tech also believes that we must continually verify client needs, expectations, and quality requirements as work progresses. Accordingly, Tetra Tech's corporate policy is to implement a proactive quality program, backed by strong management commitment, to help identify and meet or exceed client requirements. Tetra Tech's policy is to apply the following QA, QC, and quality improvement activities to our programs and projects:

- Develop project-specific plans that incorporate the QA and QC elements necessary to ensure that the deliverables and services produced will meet or exceed client requirements.
- Implement the QA and QC procedures necessary to provide a documented, consistent level of quality for all work completed.
- Provide independent reviews of work products to ensure that these products are of acceptable quality and meet client requirements.
- Document that data collected, stored, reported, and used are scientifically valid and defensible.
- Identify QA and QC deficiencies that may affect the quality of Tetra Tech's work and resolve these deficiencies expeditiously.
- Use QC check processes to identify process improvements that can be implemented as a proactive means of building quality into Tetra Tech's work products and enhancing the client experience.
- Obtain employee and client feedback on a regular basis as a means of evaluating QMS effectiveness and Tetra Tech's overall performance on a program or project.

TETRA TECH QUALITY COUNCIL

The management of Tetra Tech recognizes the necessity for a comprehensive quality program to address our complete line of consulting, engineering, remediation, and construction services. The Tetra Tech Quality Council is a permanent, standing committee comprised of senior management from various operating units representing all four business group service lines of the company. The Council's charter is to oversee the development of quality program policy, review program adequacy, and direct management assessments of quality programs. Director of Quality Programs, as delegated by the Chief Executive Officer (CEO) of Tetra Tech, heads the Council. The Director of Quality Programs is responsible for the development and administration of the quality policy, reporting directly to the Tetra Tech CEO and supported by the Quality Council.

By signature, the responsibility and authority for the policies described in this manual have been assigned to the Director of Quality Programs and to the Tetra Tech Quality Council to maintain, continually improve, and administer the Tetra Tech quality policies and practices. Tetra Tech has developed a comprehensive set of policies and practices to ensure quality objectives are attained and minimize the possibility of compromises that could adversely affect the quality of our internal operations and the services we provide to our clients. Our QMS, as described in this manual, is responsive to and follows the guidance and applicable requirements of the American National Standards Institute (ANSI) / ISO / American Society for Quality (ASQ) Q9001-2008, *Quality Management System Requirements Standard* and ANSI/ASQ E4-2004, *Quality Management Systems for Environmental Data and Technology Programs*. We are currently in the process of reviewing and updating, as necessary, our quality systems for compliance with the most recent version of ANSI/ASQ E4 (February 2014).

This Quality Management Plan will be revised and amended as necessary to reflect changes in quality requirements/policies. The goal and purpose of the plan are to ensure the quality and reliability of our services. Tetra Tech recognizes its responsibilities as a supplier of services to fully comply with all contractual provisions and governing regulatory specifications and requirements.

William R. Brownlie, PhD, PE, Senior Vice President
Chief Engineer and Director of Quality Programs
Tetra Tech, Inc.

1.0 PURPOSE AND SCOPE

This QMP identifies and describes the elements of Tetra Tech's QMS that are integral to the diverse range of services to be provided by Tetra Tech under the Project. A Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) will be prepared to cover specific QA/QC requirements for individual tasks in more detail. This QMP is written as a management plan in accordance with EPA/240/B-01/002, and discusses the quality policies for environmental and engineering practices in a general perspective that apply in the absence of more specific quality-related documents.

This QMP provides the framework and basic QA/QC requirements that will be used to develop the detailed UFP-QAPP and other QMS implementation procedures required to meet specific client requirements. Other quality-affecting plans and implementing documents will contain applicable QA/QC requirements based on the policies outlined in this QMP.

1.1 Applicability

The quality management requirements outlined in this QMP apply to all work that Tetra Tech conducts for GSH and also to all subcontractors that perform work for Tetra Tech as part of this program. Specifically, Section 2.0 – Management Systems describes the overall management of our QMS and addresses the requirements of ANSI/ASQ E4. Section 3.0 – Service Area Quality Management Policies and Practices applies to activities involving the generation, evaluation, and reporting of environmental data; preparation and production of document and information technology (IT) deliverables; engineering design services; construction/fabrication of systems and components; operations and maintenance (O&M) of systems; and verification and acceptance of systems. Section 3.0 addresses QA/QC activities applicable to these varied services areas.

1.2 Quality Management System Implementation Plans

To support this QMP as well as Tetra Tech's QMS, individual quality program plans (to include the UFP-QAPP) will be developed as applicable to contain distinctive information and requirements necessary for specific project areas. The development of these quality program plans will typically occur as part of distinct remedial activities to expand on specific details, implementation tools, and documentation schemes and systems. Thus, information or requirements not fully addressed in this QMP will be covered in these plans providing full guidance for managing the quality of Tetra Tech environmental activities.

1.3 Quality System Approach

Our quality system approach applies the fundamental principles of the "Plan-Do-Check-Act" model of continuous improvement (Figure 1). QA/QC activities are identified during project planning and applied throughout the project life. QA activities help guide the project work based on professional and regulatory standards. QC activities occur at key milestones to confirm project quality. Continuous improvement is achieved on a project by applying these QA/QC activities, as well as on future activities/projects by applying lessons learned.

Our project teams are Tetra Tech's front line for ensuring quality performance. Regardless of a project's specific attributes, planning and executing high-quality work, obtaining client and stakeholder feedback, and adjusting to improve our services and work products are all critical to Tetra Tech's long-term success. All Tetra Tech personnel play a critical role in this pursuit.

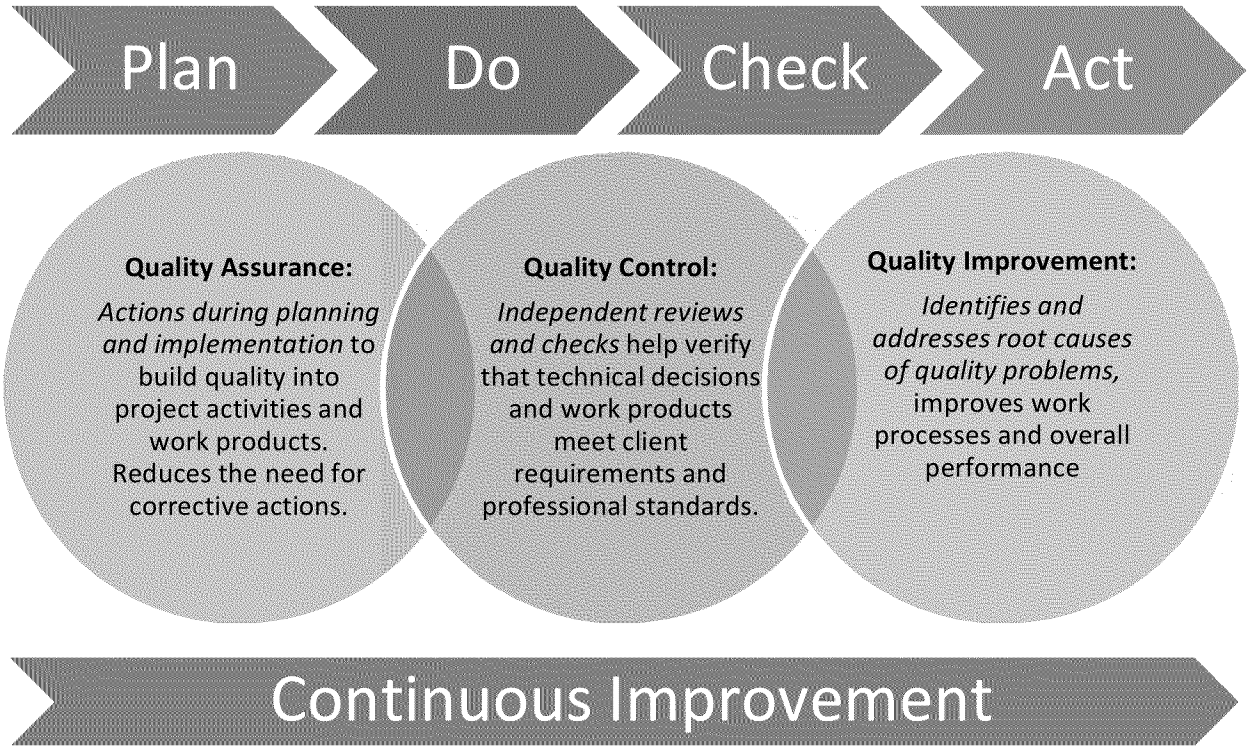

Figure 1: Tetra Tech Plan-Do-Check-Act Model

1.3.1 Plan: Quality Management Planning

The success of a project or task is highly dependent on proper planning. Quality is built into the Project at the planning stage. Quality-related plans will define:

- Tetra Tech roles and responsibilities
- Client requirements
- Key program elements
- Processes and steps to be taken
- Identified risks and mitigations

1.3.2 Do: Implementation, Self-Inspection, and Completion

Key elements to conducting the implementation, self-inspection, and completion process will include:

- Communicating the plan and its importance to the team
- Making the plan visual using procedures, regulatory requirements, statement of work, drawings, and specifications
- Identifying those actions needed to be successful, and clearly defining quality objectives
- Executing the plan through procedural and regulatory compliance

- Providing status of actual progress versus plan
- Conducting self-inspection of work as it progresses
- Stating the completion requirements of the project when the project begins

1.3.3 Check: Checking Work

Before, during, and after a project – as well as individual tasks of a project – begins, the check process is continually occurring. Checking is the process of collecting and evaluating information to the criteria established during the planning phase:

- Checks are conducted through discipline reviews and team reviews
- Document (plans, statements of work, specifications, drawings, forms) checks are conducted through peer reviews and assessments
- Work can be checked through independent (external and/or internal) inspections and testing, audits, and surveillances
- Suppliers are evaluated by capabilities, qualifications/certifications, and management systems
- Project reviews check the status of project objectives, including: schedule, scope, budget, and level of quality; quality objectives as defined in task implementation plans and work plans; and final client reviews and acceptance.
- Deviations from the Plan Step as determined during the Check Step are fed to the Act Step.

1.3.4 Act: Corrective Actions

After checking is performed, either work continues as planned or deviations are identified. Once deviations are identified, the plan needs to be changed, the process needs to be changed, or a combination of the two. Acting on deviations identified in the checking step will result in a corrective action plan that will include lessons learned, event reports, corrective actions, and continuous iimprovement.

2.0 MANAGEMENT SYSTEMS

Management Systems include the common quality management functions such as leading, planning, organizing, and controlling QA/QC activities, plus specific activities that enable project-specific operations to be planned, implemented, and assessed. The elements contained in Section 2.0 are used in conjunction with the other sections of this QMP to formulate a complete QMS. Program elements discussed in Section 2.0 include the following:

2.1 Management and Organization

2.2 Quality Management System Description

2.3 Personnel Qualification and Training

2.4 Procurement of Items and Services

2.5 Documents and Records

2.6 Computer Hardware and Software

2.7 Planning

2.8 Implementation of Work Processes

2.9 Assessment and Response

2.10 Continuous Quality Improvement

Tetra Tech management determines the requirements to meet client needs based on Tetra Tech's understanding of the scope of work (SOW), and is responsible for meeting those needs as a measure of quality and success. Individuals performing work will comply with the requirements of this QMP and the applicable Tetra Tech procedures and documents to ensure the desired level of quality.

2.1 Management and Organization

2.1.1 Purpose and Scope

This section describes the matrix organization and authority for the development, implementation, and assessment of the QMP. This section also documents the organizational structure, functional responsibilities, levels of authority, and lines of communication established within Tetra Tech to achieve quality work and data. Specific individuals with responsibilities and authorities related to individual SOW activities will be discussed in the UFP-QAPP and/or other quality-related plans developed during the course of the Project.

2.1.2 Responsibilities and Authorities

The Quality Lead, under the auspices and authority of the Director of Quality Programs, is responsible for overseeing the administration of the quality program for the Project. Individual quality points of contact (POCs), to be named in the applicable quality-related plans, are responsible for the administration of the quality requirements for their respective tasks. Tetra Tech's quality program organization, as illustrated in Figure 2, provides an independent framework for implementing quality practices.

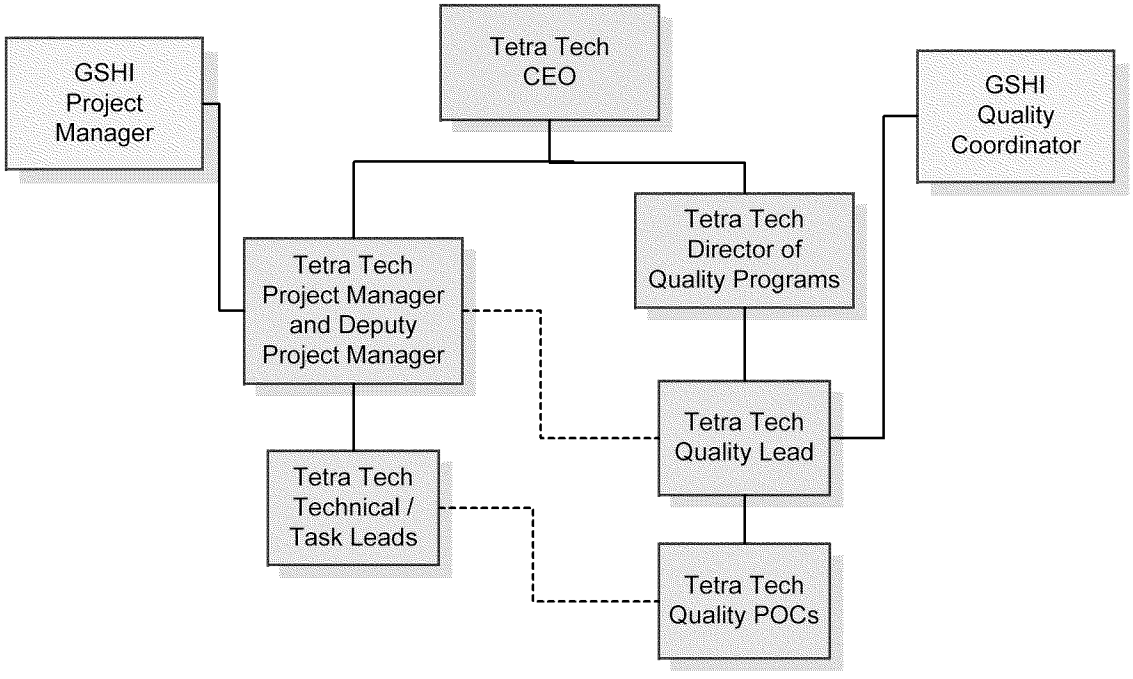

Figure 2: Tetra Tech Quality Program Organization Chart

2.1.3 Inherent Responsibilities

Ensuring achievement of the expected quality level is the inherent responsibility of every Project Manager and every individual or group engaged in performing work. These responsibilities include initiating action to prevent the occurrence of product/service nonconformance, identifying and recording any product/service nonconformance, identifying root causes and corrective actions, verifying corrective actions have been implemented, and initiating control procedures to prevent the use of nonconforming products/services or procedures.

2.1.4 Records

Quality management records shall be developed and maintained in project files in accordance with client- and task-specific requirements as discussed further in Section 3.0 of this QMP. Storage, maintenance, retention, and final transmittal requirements are implemented in accordance with Section 2.5 – Documents and Records.

2.2 Quality Management System Description

2.2.1 Purpose and Scope

This QMP describes the quality practices and policies that will be implemented to ensure the production of quality results to achieve the goals for each activity undertaken. The QMP establishes the structure, defines the authority, identifies the responsibilities and documentation requirements, and provides the instructions used to manage, implement, and assess quality-affecting activities and to create project-specific quality documents.

2.2.2 Responsibilities and Authorities

Responsibilities and authorities for the work to be performed pursuant to this QMP are delineated in Section 2.1.2 — Responsibilities and Authorities.

2.2.3 Requirements and Instructions

This QMP applies to quality-affecting work performed by Tetra Tech personnel and subcontractors to Tetra Tech. The extent to which this QMP is applied will depend upon the nature and scope of the individual project activities to be performed. The level of application of the QMP and specific client quality requirements may be delineated and documented in other project- or task-specific quality-related plans such as the UFP-QAPP. This implementation approach provides a mechanism to address basic quality program requirements, while providing the flexibility to implement additional quality requirements to meet specific internal and external client expectations.

This QMP is part of a systematic management approach for planning, implementing, and assessing work to ensure that the results satisfy stated technical, administrative, and quality objectives. This QMP encompasses the policies, authorities, and requirements necessary for implementation. Procedures that implement activities are established, reviewed, and approved to satisfy the criteria of this QMP. This QMP also includes provisions to ensure that engineered systems are designed, constructed, and operated to fulfill their intended purposes and that environmental data of the quality needed are produced and documented.

This QMP includes two levels of management controls: the organizational level (Section 2.0) and the technical project level (Section 3.0). The organizational level consists of activities supporting common or standardized functions (e.g., management assessment, personnel qualifications and training, procurement policies, and document control) and establishes the basic structure for performing work. The technical project level consists of contract-specific quality activities necessary to produce the desired quality of products, data, and results.

2.2.4 Records

QMPs, QAPPs, and other quality-controlling plans are documentation developed as part of the QMS.

2.3 Personnel Qualification and Training

2.3.1 Purpose and Scope

Tetra Tech management is responsible to ensure Tetra Tech and subcontractor personnel are sufficiently trained, qualified, or certified, where appropriate, to perform work within their specific work scope. Tetra Tech and subcontractor personnel performing work in accordance with this QMP are selected based on their qualifications to perform their assigned work according to the requirements of this QMP and other project documents and to contract-specific requirements. Tetra Tech emphasizes education and training for our employees. Employee education and training helps achieve and maintain proficiency, while creating an environment that promotes individual responsibility and accountability for quality. This requirement applies to personnel performing or managing activities directly affecting quality.

2.3.2 Responsibilities and Authorities

Tetra Tech management is responsible for the following:

- Determining the level of education, experience, and training required to ensure that Tetra Tech personnel are qualified to perform work. Specialized training requirements needed to accomplish highly technical work activities are identified in work plans, QAPPs, and standard operating procedures (SOPs).

- Establishing specific requirements for indoctrination, subject matter training, qualification, certification, personnel training records (and their maintenance), and implementation in accordance with project procedures.

- Providing training resources for required education, training, and retraining, including activities such as continuing education, on-the-job training, and training seminars to ensure that personnel demonstrate and maintain proficiency in performing assigned work.

- Ensuring that when job requirements change, the need for retraining is evaluated by Tetra Tech management and provided when necessary.

- Ensuring that records of training, qualification, and certifications are maintained.

2.3.3 Requirements and Instructions

Tetra Tech management must perform the required actions to accomplish the specific responsibilities identified in Section 2.3.2.

Tetra Tech personnel selected to perform work shall possess the education, experience, and training commensurate with the specified activity.

Where required by statute or other applicable requirement, personnel may be required to be qualified and/or certified to conduct specific work. Management and workers must achieve specific requirements for qualification and/or certification to meet specific needs.

2.3.4 Records

Records generated through implementation of the requirements of this section of the QMP include documentation needed to support successful accomplishment of training, qualification, and certification. Records may include one or more of the following documents applicable to the type of experience, education, and/or training provided:

- Course or training outline or similar documentation of the subject matter of the course or training offered, when course training is used

- Records of training duration

- Test or examination results or other documentation indicating proficiency as applicable

- Records directly related to historical work experience or training

- Copies of qualification or certification documents issued

- Job Classification training requirements for Tetra Tech employees

Education and training records of Tetra Tech employees are documented and managed to provide evidence of successful completion; records are maintained in employee files with their local Human Resource representatives.

2.4 Procurement of Items and Services

2.4.1 Purpose and Scope

This section of the QMP defines a QMS to ensure that procurement processes are properly documented and controlled and that procured items and services conform to established requirements.

2.4.2 *Responsibilities and Authorities*

Tetra Tech's contracting and procurement personnel are typically responsible for the following:

- Controlling procurement documents (e.g., master ordering agreements, purchase requisitions, purchase orders, basic ordering agreements, service contracts)
- Adhering to the Tetra Tech procurement requirements
- Securing replacement, or remedy, for suppliers of deficient items and services

Project Managers are responsible for the following:

- Providing contracting and procurement personnel with appropriate specifications, drawings, SOWs, and other documentation necessary to obtain suitable and acceptable items and services and to flow down quality and technical requirements to suppliers
- Ensuring that the appropriate technical reviews of procurement documents are conducted prior to the distribution for bid
- Identifying quality-affecting items and services to the contracting and procurement personnel and the Quality Lead or Quality POCs
- Ensuring that documents used for procurement of items and services include appropriate quality requirements (e.g., applicable specifications, standards, regulations, drawings, and a SOW including quality requirements)
- Ensuring QMSs, workmanship standards, acceptance test procedures, test correlation, and other appropriate quality and technical requirements are included in subcontract SOWs for products and services procured from subcontractors and suppliers
- Documenting and tracking the disposition of supplier responsible product non-conformances

The Quality Lead, or a designated Quality POC, is responsible for the following:

- Performing subcontractor procurement evaluations when requested by management or the Project Manager
- Providing methods for determining the level of supplier quality through assessments, inspections, surveillance, tests, and certifications to verify compliance of items and services to procurement document requirements, upon Tetra Tech management request

2.4.3 *Requirements and Instructions*

The Tetra Tech project personnel define the specifications of each requirement to be subcontracted and verify that quality requirements are clearly stated and appropriate for the program or project. The specifications and other project-specific criteria make up a comprehensive statement of work that addresses subcontractor performance objectives and deliverable requirements.

Suppliers providing items and services according to the requirements of this section are required to have a system capable of ensuring items and services meet requirements of the procurement document. Assessment of the supplier's QA approach relative to the SOW may be completed as part of the review of the bid package or proposal. Suppliers must incorporate appropriate quality requirements in their sub-tier procurement documents as appropriate.

2.4.4 Records

The QA records generated through implementation of the requirements of this QMP include the following:

- Copies of pertinent portions of procurement documents
- Reports on supplier evaluations from the procurement group and technical personnel
- Reports on monitoring supplier quality

2.5 Documents and Records

2.5.1 Purpose and Scope

Documents developed for use in project activities, including those affecting quality, will be prepared, reviewed, approved, distributed, revised, indexed, filed, stored, maintained, retrieved, and transmitted to the client according to requirements specified in Tetra Tech procedures. Documents may include, but are not limited to, the following:

- Tetra Tech Health and Safety Plan (HASP)
- Tetra Tech UFP-QAPP and QAPP Addenda
- Sampling Plans
- Procedures and SOPs
- SOWs
- Design packages (30, 60, 90, and 100 percent designs)
- Specifications

Records are generated and used to document the quality of items, services, environmental processes, and engineered systems and require the same controls as documents discussed above. Specific records generated by performance of activities associated with this QMP are identified within each specific section, within the UFP-QAPP, and/or within plans or specifications used to perform specific tasks. The QA records may be in the form of handwritten, printed, or electronic media. Quality records to be controlled by this QMP include only those that furnish documentary evidence of the quality of items, services, environmental processes, and engineered systems. The term record(s) used throughout this QMP denotes quality records.

2.5.2 Responsibilities and Authorities

Tetra Tech Project Managers are responsible for implementing a document control and records management system to ensure clarity, completeness, retrievability, and conformance to contract and procedural requirements.

Originators and, to a lesser extent, custodians of documents and records are responsible for the following:

- Legibility, accuracy, and completeness of documents and records

- Preparation, review, issuance, and revision(s) of documents and/or records that specify quality requirements
- Proper filing of documents and records by following project filing procedures

The Project Manager is responsible for ensuring that reports, technical plans, design documents, and other technical deliverables are subjected to an internal review and approval process. The Quality Lead is responsible for assessing the effectiveness of the implementation of document and record requirements. Project Managers are responsible for maintenance, issuance, retrieval, filing, and final transmittal to the client of project records.

2.5.3 Requirements and Instructions

Document control and records management include: (a) identification of documents and records to be managed and their specified distribution; (b) identification of assignment of responsibility for preparing, reviewing, approving, and issuing documents; and (c) review of documents for adequacy, completeness, and correctness prior to approval and issuance. Prior to issuance, deliverable document revisions shall follow the review and approval processes outlined in Section 3.2 of this QMP.

Special requirements for records include validation, indexing, record accuracy, maintenance, and final transmittal. Maintenance of records shall include provision for retention, protection, preservation, traceability, retrievability, and final transmittal.

2.6 Computer Hardware and Software

2.6.1 Purpose and Scope

This section of the QMP addresses computer hardware and software used in Tetra Tech activities. Hardware includes network servers and disk drives, electrical components, personal computers, and printers. Computer programs are synonymous with software. Computer programs addressed by this QMP include, but are not limited to, design, design analysis, models of environmental processes and conditions, operations or process control, and databases. Computer programs not addressed by this QMP include, but are not limited to, nontechnical software such as word processing applications.

2.6.2 Responsibilities and Authorities

The Tetra Tech Corporate IT Department is responsible for software installation and support, maintenance and support of computer-related equipment, maintenance of the computer network, computer-related equipment troubleshooting, ensuring network security, maintaining electronic mail, and maintaining an inventory of computer-related hardware and equipment.

All Tetra Tech personnel are responsible for meeting Tetra Tech corporate computer use policy.

2.6.3 Requirements and Instructions

Computer program development for technical project applications is accomplished using an approved software development methodology. Internally developed technical programs are validated, verified, and documented according to the intended use of the software. Test requirements for internally developed software include verification tests, in-use tests, testing procedures, documentation of results, and control and maintenance of test records. Documentation of software test results is maintained.

Revisions to verified computer programs are controlled and assessed to determine the potential impact of the change on the performance of the software. Revised computer programs are verified and documented according to the same procedures required for the original program.

Computer programs that are commercially available, have been widely used, and can be reasonably assumed to be correct may not require independent verification.

2.6.4 Records

QA records generated through implementation of the requirements of this section of the QMP include records documenting acceptance of computer hardware and software, inventories of computer-related hardware and equipment, and verifications of internally developed technical computer programs.

2.7 Planning

2.7.1 Purpose and Scope

This section describes the planning process that Tetra Tech implements for projects, as well as individual tasks within a project. Planning is conducted in accordance with established procedures to accomplish several objectives.

Planning provides a basis through which the following project objectives can be defined:

- Implementation and completion of the defined SOW
- Completion of an assigned task within the approved and agreed-upon schedule
- Performance of the task work within established project budgets
- Meeting the technical and quality goals of the client and the identified acceptance criteria

Planning establishes and confirms agreement on the details of these project objectives and provides guidance on the conduct of tasks to project personnel. In addition, planning provides a base for forecasting and monitoring progress on project tasks.

2.7.2 Responsibilities and Authorities

The Project Manager is responsible for ensuring Tetra Tech projects are planned in accordance with corporate procedures and policies and for planning and executing the SOW to GSH's satisfaction.

2.7.3 Requirements and Instructions

Projects and supporting activities are planned, and planning documentation is reviewed, approved, and documented. The amount of detail in the planning documents depends on the scope, complexity, and significance of the portion of the Project being planned. Organizational responsibilities, interfaces, and implementing instructions are identified during planning and maintained throughout the work. Organizations assigned responsibilities are included in the review process, and their comments are resolved prior to the start of that specific work. Typical elements associated with most project planning activities include:

- Tasks needed to complete the work using work breakdown structure techniques and critical dependency relationships between tasks
- Schedules for completing individual tasks to achieve the overall project schedule

- Resources needed to perform each task (labor, equipment, supplies, and services)
- QA/QC requirements and quality leads
- Specific actions planned to ensure the client's performance expectations are met or exceeded
- Control mechanisms to monitor budget, schedule, quality, and client satisfaction during project implementation

2.7.4 Records

The QA records generated through implementation of the requirements of this section include completed copies of approved project planning documents.

2.8 Implementation of Work Processes

2.8.1 Purpose and Scope

Work conducted by Tetra Tech is planned, implemented, and assessed according to applicable sections of this QMP. The work processes and operations discussed in this section of the QMP relate to quality-affecting processes and operations. Contract-specific requirements for work processes and operations are discussed in the UFP-QAPP and other individual quality-related planning documents. Basic QA/QC elements applied to most common areas of service are further described in Section 3.0 of this QMP.

2.8.2 Responsibilities and Authorities

Project Managers are responsible to plan, implement, and assess work processes.

Managers must identify applicable basic contract quality requirements, program and task expectations, and the project SOW during the work planning process. This planning process occurs before and during the initiation of individual contracts.

Responsible managers must establish policies and procedures to address identification of routine operations requiring plans; preparation of plans including form, content, and applicability; and documented approval of plans.

Tetra Tech managers are responsible for performing assessments of compliance and effectiveness of work processes under their control. The Quality Lead and support staff are responsible for performing independent assessments of work processes impacting quality. Tetra Tech and subcontractor personnel are required to perform work according to approved documents.

2.8.3 Requirements and Instructions

The basic requirements for controlling work processes and operations are discussed below:

- Planning for quality is conducted according to a graded approach by addressing the nature, complexity, and SOW to be performed. The graded approach defines the extent and degree of the level of quality applied to work activities.
- Planning and implementation for characterization of environmental processes and conditions are guided by determination of the level, type, quantity, and quality of data required (see Section 3.1).

- Planning and implementation for engineered systems include determination of the appropriate design criteria and design bases and any specially controlled conditions required to ensure that objectives are satisfactorily achieved (see Section 3.3).

- QMS requirements for construction and O&M services are guided by construction quality management plans, SOPs, and other project specific plans and procedures (see Sections 3.5 and 3.6).

- Work is performed according to approved work plans, drawings and specifications, QAPPs, sampling plans, SOPs, and other applicable documents or procedures.

- Work is implemented in a sequence consistent with the need for completion of prerequisite as well as final operations.

- Plans are developed and implemented for appropriate routine and standard work operations. Specialized and/or critical operations may use project-specific documents to perform work operations.

- Management assessments of work processes and operations are accomplished through self-assessments and independent assessments. Assessments are conducted according to the requirements of Section 2.9 – Assessment and Response

2.8.4 Records

Records generated through implementation of the requirements of this section include program and project records such as SOWs, work plans, and procedures identified in Section 3.0 and assessment records as identified in Section 2.9 – Assessment and Response.

2.9 Assessment and Response

2.9.1 Purpose and Scope

Tetra Tech management will regularly assess the adequacy of the QMS and ensure its effective implementation. Quality assessment activities are typically delegated to qualified professionals by Tetra Tech management to ensure that an effective QMS has been established, implemented, and followed. Assessments are planned and documented based on program or project requirements. Approaches used for assessments will vary with the objectives of the assessment and the status of the project. Assessment activities will be performed in accordance with the requirements of this QMP. Additional task-specific requirements for assessments are discussed in the UFP-QAPP and individual quality-related planning documents.

Additionally, the Tetra Tech quality organization may conduct a needs-analysis identifying the needs of each portion of the Project, specifically those areas that pose the greatest risk to the Project's success. By targeting high risk areas, Quality Management can assist Project Management in developing effective mitigation strategies for high risk activities or deficient areas.

2.9.2 Responsibilities and Authorities

The Quality Lead, with support from staff assigned to support the quality process (i.e., Quality POCs), has prime responsibility for conducting independent assessments and for implementing corporate and project QMS requirements. Independent assessments evaluate the performance of work processes with regard to QMS requirements, compliance and expectations for safely performing the work, and achieving the goals of the project and organization.

Management assessments require direct participation of affected levels of management. Both organizational level and technical level leads are responsible for ensuring that assessments are

completed to determine the quality of products and technical work and adequate implementation of the corporate procedures. Tetra Tech management implements effective corrective actions to remedy problems discovered by management assessments. Independent management assessments may be performed as determined by the Project Manager or the Director of Quality Programs. Independent management assessments are used to evaluate the performance of the work process and the application of and compliance with programmatic requirements.

2.9.3 Requirements and Instructions

Assessments provide a means for determining the following:

- Effectiveness of the management control system used to achieve and ensure quality
- Adequacy of resources and personnel provided to implement and ensure the quality of Tetra Tech activities
- Adequacy, implementation, and compliance with the corporate and project plans and procedures

Management and technical independent assessments will be conducted by management and QA/QC personnel to provide an objective and unbiased evaluation of the QMS and project-specific requirements. Independent assessments are conducted by those who are not performing or responsible for specific work and who possess the necessary technical or management skills to perform the assessment. Management and technical self-assessments are conducted by those responsible for specific work. Independent assessments associated with deliverable reviews are further detailed in Section 3.2 of this QMP.

Tetra Tech management determines the response actions necessary as a result of independent assessments and self-assessments and implements appropriate corrective actions. Tetra Tech management shall perform follow-up assessments to determine the effectiveness of implemented corrective measures and to confirm that corrective actions prevent a recurrence of the problem.

Assessment tools consist of audits, surveillances, peer reviews, readiness reviews, and technical reviews.

2.9.4 Records

Records generated by implementation of this section of the QMP include the following:

- Assessment (Audit, Surveillance, and Inspection) Plans and Reports
- Nonconformance Reports

2.10 Continuous Quality Improvement

2.10.1 Purpose and Scope

The Tetra Tech Corporate Quality Program fosters continuous process improvements. This includes: identifying opportunities for improvement, implementing improvements, and monitoring the impact of the improvements. The intent is to improve operations and work processes, thus providing better value. The principles of continuous quality improvement include understanding the client's requirements and expectations, implementing quality improvement "tools," involving all personnel in the improvement process, and measuring the impact of improvements on applicable operations, services, and products.

2.10.2 Responsibilities and Authorities

Tetra Tech managers conduct quality improvement activities to enhance work processes and detect/correct problems that adversely affect quality during planning, implementation, and assessment of technical and management activities. The improvement system employed by Tetra Tech management involves various components including, but not limited to, quality committee evaluations, management assessments, lessons learned evaluations, and corrective and preventive action implementation. The improvement system focuses primarily on exceeding internal and external client requirements and expectations, thus indirectly and/or directly providing more value to clients.

Tetra Tech management is required to develop and implement solutions to correct quality-affecting problems, thus supporting and augmenting the overall improvement process. Project managers and department heads identify applicable performance data to analyze and detect trends that adversely impact quality.

2.10.3 Requirements and Instructions

Tetra Tech uses the assessments discussed in Section 2.9 of this QMP as a means to identify components of the QMS that are not functioning effectively and need corrective action. Technical system audits are identified and overseen by the Quality Lead. Corrective actions resulting from Tetra Tech's assessment activities can be immediate or long-term. Immediate corrective actions will include revising a test procedure that is not working effectively or correcting errors or deficiencies in documentation. Long-term corrective actions represent an opportunity to build quality into project planning and implementation activities rather than relying on deliverable reviews and audits to identify and correct errors and deficiencies.

2.10.4 Records

The QA records generated through implementing this section of the QMP include the records of the assessments described in Section 2.10.3 above.

3.0 SERVICE AREA QUALITY MANAGEMENT POLICIES AND PRACTICES

Section 3.0 of the QMP contains service area-specific QA/QC elements needed to plan, implement, and assess project tasks performed by Tetra Tech and/or subcontractors. These elements are used in conjunction with the management systems described in Section 2.0 to address the entire scope of Tetra Tech's QMS. The following program elements are contained in Section 3.0:

3.1 Environmental Data Collection and Use

3.2 Document Deliverables

3.3 Engineering Design

3.4 Construction Management

3.5 Construction

3.6 Operation and Maintenance

3.7 Commissioning and/or Verification and Acceptance of Systems

These project activities encompass virtually all work performed and completed by Tetra Tech, and may include services not required at this time under the Project; however, they are included for completeness and the potential for future modifications to project needs. Individuals performing work that affects quality will comply with the policies and practices identified in this QMP and subordinate procedures and documents.

3.1 Environmental Data Collection and Use

3.1.1 Purpose and Scope

This section of the QMP defines the QMS requirements to ensure that projects involving the generation, acquisition, and use of environmental data are planned and documented. Detailed requirements for planning and scoping are discussed in the UFP-QAPP or other individual quality-related planning documents.

3.1.2 Responsibilities and Authorities

A Tetra Tech Project Manager is responsible for activities involving the collection and evaluation of environmental data including the following planning and scoping activities:

- Determining data assessment tools (i.e., program technical reviews, peer reviews, inspections, surveillances, and audits) as needed and/or specified in the QMP
- Providing training activities as necessary to meet specific data requirements contained within individual task-specific SOWs per the requirements of Section 2.3 – Personnel Qualification and Training, and related project-specific requirements
- Providing training considerations specific to work on individual tasks as discussed in the UFP-QAPP or other quality-related plan
- Managing the collection and processing of data
- Ensuring the data are properly identified, recorded, authenticated, and filed

The Quality Lead is responsible for ensuring that the policies and practices outlined in this section of the QMP are implemented and for ensuring the applicable quality planning documents for data collection are developed, approved, and followed.

3.1.3 Requirements and Instructions

Data collection and use involve four critical components that must be accomplished in concert to ensure the data are useable, complete, and defensible for their intended use. The four critical components are: (1) planning, (2) implementation, (3) assessment, and (4) storage. Our QA/QC policy for data collection and use encompasses management and technical activities used in support of our client services. This policy focuses primarily on the collection and use of primary data; however, similar requirements are applied to secondary data based on client requirements and needs. Primary data are defined as *information collected directly for measurements under a subject project (e.g., sample data results, field measurements)*. Secondary data are defined as *existing data collected for other purposes or obtained from other sources outside the project (e.g., literature sources, industry surveys)*.

The level of sophistication and detail applied to each of these critical components is scalable based on the professional judgment of the project management. However, all four components must be addressed and documented as part of each project effort.

3.1.3.1 Planning

The following procedures apply to data collection activities to ensure that data collected meets the intended problem solving or decision making needs of the activity:

- Systematic planning is used to define the data needs and performance criteria (i.e., the type, quantity, and quality of data needed for a specific purpose) for the data collection activity. The EPA *Guidance on the Use of the Data Quality Objective Process* (EPA QA/G-4) outlines primary methods to be followed for environmental data collection planning and will be applied at a various levels of detail depending on the project task. Other applicable government guidance or less rigorous processes may be applied as appropriate, but must involve definition of data needs and collection methods, performance criteria for use of data, and data collection boundaries (spatial and temporal).

- Sampling plans are prepared and followed that document data collection needs, approaches, quality requirements, and QC activities needed to ensure the performance criteria are satisfied. Sampling plans may range from a detailed UFP-QAPP prepared in accordance with applicable government requirements (e.g., EPA-505-F-03-001EPA, *Uniform Federal Policy for Implementing Environmental Quality Systems;* EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans*) to summary tables that document number and types of samples and reference field data collection SOPs.

3.1.3.2 Implementation

Data shall be collected using approved methods and procedures documented in the UFP-QAPP, individual task-specific sampling plans, and/or SOPs. The following components apply to Tetra Tech data collection activities:

- Data collection is conducted in accordance with written procedures either referenced or included in the sampling plans. Procedures may be developed at the organizational/ program, project or task level depending on the requirements. Nevertheless, each field measurement and sample activity shall be guided by a written procedure to ensure the field activities are conducted appropriately and the resultant data is usable. Procedures will address, as applicable, calibration and use of field testing or measurement equipment, sample collection and handling, and field documentation.

- Field documentation shall be completed for data collection activities and maintained in project files as per the client contract requirements or corporate document retention policy requirements. Field documentation should include field log books and field measurement forms.

- Standard test methods shall be applied to field measurements and samples submitted for offsite testing or analysis. Examples of standard test methods include *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA SW-846), American Society for Testing and Materials (ASTM) standard test methods, and other equivalent recognized and accepted methods. If non-standard methods are used, the method shall be described and approved prior to conducting the work.

3.1.3.3 Assessment

Data assessments shall be completed on data collected prior to their use. These assessments will be used to confirm that the data are acceptable for their intended use and meet the performance criteria established during the project planning.

Data verification and/or validation shall be performed for laboratory data received and used in support of project goals. The level of data validation shall be consistent with applicable regulatory requirements, client procedures, and professional due diligence. Data review may range from (1) a cursory review from a qualified professional to ensure there are no key analytical issues/deficiencies that prevent the data results from being used to (2) an independent third party validation as specified by regulatory agencies or client requirements, such as EPA requirements under *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8) EPA/240/R-02/004, November 2002.

Other data assessment activities shall be completed to the level specified by regulatory or client requirements and include:

- Evaluating field records for completeness and consistency

- Ensuring a sufficient amount of data was collected to achieve the established degree of precision

- Determining if the data are of appropriate quality to achieve their intended use and make a decision with an acceptable established level of confidence or make an estimate within a desired level of uncertainty

These data assessment activities shall be documented in project reports that use the subject data.

3.1.3.4 Storage

Data storage requirements shall be defined at the beginning of data collection efforts and may involve electronic or hard copy storage based on client requirements and usage. Data shall be managed to ensure its integrity and reproducibility.

Data integrity shall be maintained through use of electronic data deliverable (EDDs) procedures and database management systems. When manual data transfer is conducted, QC procedures shall be established and followed to ensure the accuracy of the data transfer. Both electronic and manual procedures shall be defined at the program or project level depending on client requirements and needs.

Data reproducibility shall be maintained through data storage security and controls. Electronic data shall be stored in secured servers or data storage devices that include standard back up protection

protocols. Hard copy data shall be maintained in project files or other secured areas. Records shall be legible and stored and retained in such a way that they are readily retrievable. Data storage facilities shall provide a suitable environment to prevent damage, deterioration, or loss. Both hard copy and electronic files shall be maintained as required by the contract or for at least 10 years as per Tetra Tech requirements.

3.1.4 Records

The QA/QC records generated through the implementation of the requirements of this section of the QMP include the following:

- Approved project-specific plans and revisions
- Laboratory data reports and/or EDDs
- Data Validation Records

3.2 Document Deliverables

3.2.1 Purpose and Scope

This section of the QMP identifies QA policies and practices to ensure that the processes for development of document deliverables are defined, verified, and controlled. The policy for document deliverables shall identify relevant activities pertaining to the preparation of high quality documents. In addition, the basic QA policy for electronic deliverables is also specified.

3.2.2 Responsibilities and Authorities

The Tetra Tech Project Manager and individual technical leads/managers directing or supporting project-specific tasks are responsible for the following requirements as appropriate:

- Approving deliverable preparation procedures, instructions, specific personnel, applicable requirement documents, authorities, and subsequent revisions or cancellations
- Ensuring that persons knowledgeable in the technical disciplines and appropriate administrative details perform reviews
- Providing reports regarding the status and quality of document deliverables and results of assessment activities to program/project management, as well as supporting organizational management

The Quality Lead is responsible for the following:

- Ensuring independent review processes are established and followed for deliverable preparation and production
- Ensuring incorporation of appropriate quality requirements in document preparation procedures
- Developing an assessment schedule of and overseeing document reviews
- Providing the Project Manager with assistance to evaluate and control activities related to deliverable completion and production

3.2.3 Requirements and Instructions

Tetra Tech is committed to producing quality written documents and electronic work products that respond to the client's needs, fulfill contract requirements, and are in accordance with sound engineering and scientific practice. This policy requires that review procedures be established and implemented for project deliverables. Tetra Tech subscribes to ANSI's definition of peer (technical) review and the expectations that written work products will undergo independent peer reviews as defined by ANSI:

> "A peer review is conducted by qualified individuals or organizations independent of those who performed the work, but are collectively equivalent in technical expertise to those who performed the original work. A peer review is conducted to verify that activities are technically adequate, competently performed, properly documented, and satisfy established technical and quality requirements. A peer review is an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to specific work and to the documentation that supports them. Peer reviews provide an evaluation of a subject where quantitative methods of analysis or measures of success are unavailable or undefined."

Our procedure was established to ensure consistent application of the review process cited above.

3.2.3.1 Deliverable Reviews

It is Tetra Tech's policy that document deliverables undergo a peer review by a qualified professional independent of the task. Tetra Tech's deliverable review process typically requires technical, editorial, and QC reviews. Our review process is applicable to most technical reports, plans, and other written and electronic deliverables that we prepare. The following sections describe our deliverable review procedures for each deliverable type.

Standard reports and plans will typically undergo a two- or three-level review consisting of technical and QC reviews, as well as editorial reviews where warranted. Each review step is described below.

Technical reviews shall be completed by experienced employees with direct knowledge of the technical areas addressed by a deliverable and independent from these project activities. The purpose of the technical review is to evaluate the overall technical quality of the deliverable. This is done by evaluating whether the project background is presented appropriately; the data collection and discussion are sufficient to support the deliverable's conclusions; the overall technical approach presented in the deliverable is valid; the conclusions and recommendations are justified; and the deliverable fulfills the requirements of the SOW. Multiple technical reviewers may be used for deliverables that have significant content in more than one technical area (for example, geology, chemistry, and risk assessment).

Editorial reviews are recommended for all reports and necessary for sensitive documents or documents prepared for public review. Editorial reviews should include spelling and grammar checks and should evaluate the editorial quality of written deliverables, including: whether the purpose is clearly stated; the discussion is coherent and consistent; the deliverable is clear, readable, and well-organized; data are clearly presented in tables and figures; and an appropriate summary is included. In addition, editorial reviewers may help authors plan and organize documents before the writing process begins.

A **QC review** is a final check on each deliverable before it is submitted to the client. The QC review focuses on ensuring that (1) technical and editorial review comments on the deliverable have been addressed, (2) the deliverable is consistent with overall project goals, and (3) the deliverable does not contain assertions or statements that could expose either GSH or Tetra Tech to excessive risk. The QC reviewer can require additional technical or editorial reviews of a deliverable if questions remain about technical or editorial issues.

The deliverable is released when the technical, editorial, and QC reviews have been satisfactorily completed and documented. The Tetra Tech Quality Lead, or designated representative, will monitor the deliverable review process to ensure that any significant quality issues have been resolved.

In some cases, more or less stringent review levels may be appropriate. The Tetra Tech Project Manager will discuss the required level of review for the project deliverable with the Quality Lead, and agree on an appropriate review level during the planning stages for each document. Use of a less stringent review level requires concurrence in advance of starting the review process. Either the project work plan or other planning materials developed for the Project (e.g., UFP-QAPP, technical approaches, project execution plans) are used to document the deliverable review requirements established for the Project.

3.2.3.2 Electronic Work Products

Tetra Tech's internal review process is also applied to electronic work products to ensure that client needs are met. The review process applied to electronic work products is similar to plans, reports, and other written documents, but may include additional components as applicable (e.g., programming interface requirements). Each component undergoes an appropriate level of review to ensure the quality of the entire product.

3.2.4 Records

The QA records generated by implementing this section of the QMP include the following:

- Document Review Records
- Any additional quality records generated by specific procedures, work instructions, or SOPs referenced in contract-specific documents, which may be listed within the policies and practices listed above

3.3 Engineering Design

3.3.1 Purpose and Scope

This section of the QMP establishes the quality policies and practices to ensure that designs are completed using sound engineering, architectural, and scientific principles and appropriate standards. Design activities include the technical and management processes for all stages of design including concept design and planning, formulation of design basis, contract document production, construction administration (CA), and operations documentation and training. Project-specific requirements for design services are discussed in detail in quality-related plans.

3.3.2 Responsibilities and Authorities

Tetra Tech Project Manager and technical leads are responsible for ensuring that facilities and technologies and their components are designed in accordance with contract scopes and applicable industry and client codes and standards. Tetra Tech personnel performing design activities are responsible for following the policies of this QMP and supplementary procedures specified by task-specific requirements.

The Project Manager has primary responsibility for ensuring the implementation of QC measures specified in this QMP and in task-specific standards. The Project Manager and/or task leads are responsible for delineating necessary QC procedures relating to design documents, including reports, drawings, specifications, and other documents instructive to the project design. These procedures include, but are not limited to:

- Frequency and scheduling parameters for quality reviews
- Method of documentation of review comments
- Method of documentation for back-checking and tracking the dispensation of review comments in project documents
- Method for sign-off and approval of project design documents

Management may appoint others, such as the Quality Lead and/or independent technical reviewers, to oversee, direct, and perform QC functions.

In addition to any other quality measures specified for a project, design drawings and specifications shall be reviewed and approved by a registered professional "in responsible charge" for each applicable discipline as designated by the Project Manager. Regulations under which professional licenses are issued prohibit registered professionals from placing their seal and signature on any design documents that are not prepared under their responsible charge. Although the exact wording used to describe responsible charge varies with licensing authorities, in every case the professional is required to be actively involved throughout the design process and to have authority over the technical work that ultimately produces the documents. Reviewing documents after they have been developed by others without being involved throughout the design and development process does not constitute being in responsible charge.

The Project Manager is responsible for ensuring that technical reviews and other assessments, such as constructability reviews, are performed at appropriate stages throughout the design process. The Project Manager shall ensure that design documents have been reviewed by the designated responsible parties before approving those documents.

The Project Manager is also responsible for ensuring that quality procedures are accounted for and incorporated into project schedules, particularly the necessary time for evaluating and addressing review comments.

3.3.3 Requirements and Instructions

All design personnel shall use applicable engineering procedures for preparation, review, and approval of drawings, specifications, and other design-related documents. Engineering and design procedures cover preparation, review, and approval of calculations; reports, drawings and specifications; CA related documents, such as requests for information (RFI) and engineering change notices (ECN); O&M manuals and training materials; and record drawings. The requirements apply to documents produced by Tetra Tech and those produced by Tetra Tech's subcontractors and vendors.

3.3.3.1 Data Utilized for Design

Data utilized for the purpose of design shall be reviewed by the appropriate technical leads for accuracy and completeness and to ensure that it is of an adequate level of detail to complete the design. Data utilized for design include, but are not limited to, the following types of information:

- Maps and plans of existing conditions such as utility maps or existing building plans
- Land surveys
- Geographic Information System (GIS) data

- Geotechnical reports
- Equipment data sheets

For data received from clients, agencies, subcontractors, technical vendors, or other external sources:

- The client shall be notified as to what data received from outside sources are being relied upon for design purposes since Tetra Tech's ability to confirm such data are limited. If field verification of such data, beyond what is contractually required, is desired by the client, the manner in which this verification will occur shall be determined.
- When data, such as geotechnical reports or surveys, are received from subcontractors or technical vendors under contract with Tetra Tech, the data shall be reviewed with the subcontractor or vendor. The review shall be conducted to ensure that the data meet contract requirements and include adequate project-specific evaluations and recommendations when required.

Data utilized for design shall be referenced in the design basis as described in the following section.

3.3.3.2 Design Basis

Tetra Tech creates a design basis for each project to delineate the applicable codes and standards, as well as project- and site-specific design factors, which form the basis for design calculations and methods. The design basis may be as simple as a single sheet or may comprise a manual depending on the size and complexity of the project. The design basis normally will be a "living document" that is updated as needed during the course of the project. Tetra Tech will maintain revision histories and prepare project communication plans that document the method for communicating updates and changes to the design basis. At a minimum, the design basis shall include the following information:

- Applicable codes and standards
- Project site information including location and environmental factors such as climate when applicable to the project
- Approved calculation methods
- Approved design software, including software versioning
- References to data utilized for design, including issuance and/or revision date, applied to maps and plans of existing conditions, geotechnical reports, surveys, and other items as appropriate

3.3.3.3 Design Calculations

Design calculations should be completed following the policies and practices listed below:

- Calculation methods shall be reviewed by registered professionals, scientists, or other qualified senior personnel to ensure that the calculation method is in line with project design criteria, industry, and code standards.
- All calculations shall be completed in an organized and legible fashion with adequate narratives, attachments, etc. to clearly document the purpose of the calculation.

- Calculations may be performed manually; through "computer-assisted" methods such as Excel spreadsheets, MathCAD, etc.; or via design software purchased/licensed for use by Tetra Tech.

- Manual calculations shall be completed on Tetra Tech and/or project approved calculation sheets.

- Computer-assisted output shall be "page formatted" for printing so that the output fits properly on printed sheets and includes headers/footers as needed to include requirement calculation documentation.

Manual and computer-assisted calculations shall include initials of the person performing the calculation ("performed by") and the review/approver ("approved by") on each calculation sheet. Project and design specific information including the name of the project; applicable area of the project; purpose of the calculation; date the calculation was performed; and design assumptions, parameters, and variables shall be clearly indicated. Sheets shall be numbered to indicate "Page _ of _" on each sheet. Hand and computer-assisted calculations shall include references to specific sections in codes and standards, where appropriate.

For design software, methods for validating both the computer input data and output results shall be delineated in the UFP-QAPP or other task-specific, quality-related plan. Design software often includes many options for creating output files of both input data and design results. The method of creating output files and how such files are named and stored shall be established for the project. This is particularly important when the output data are presented to and/or reviewed by the client or approving agencies. The method for documenting the review and approval of design software output shall be determined for the project – this may include a "performed by/reviewed by" cover sheet, signing hard copied output, or other means of clearly documenting that necessary reviews have occurred.

Calculation packages, which may include hand calculations, computer-assisted calculations, design software output, and other attachments, such as equipment cut sheets, shall be well organized and include a table of contents, clearly labeled exhibits/attachments, and sufficient narratives to clearly describe the purpose of the calculations.

Because design software is often replaced with new versions incompatible with past versions, or software falls completely out of circulation, it is important that "soft" copies of design software results are not relied upon as the sole means of documenting design results. In addition, not all reviewers of design data (or other parties needing to view design data) will have access to or familiarity with the design software used. Output files of final design results in file formats, such as PDF, should be generated and clearly named and stored in the project file in an organized manner. It is also important to supplement design software output with additional information that clarifies the design software results. For example, finite element software used for structural design relies upon member numbers to key output to the structural model. As such, it is important to include diagrams of the model which clearly identify the member numbering from the structural model, and which orient the model to the actual structure being designed (building grid, north arrow, etc.) so that the output can be readily keyed to the members. The use of reliable design software can save time and improve accuracy and design efficiency, but it is important to utilize some of that time saved to document and organize design software output.

Calculations for major design components must be checked by an independent reviewer. The Project Manager or Quality Lead will make a determination of which major components require independent review. The calculation "approver" may not be the calculation "preparer." Review and approval is performed by licensed design professionals or other senior science/technical professionals. In case of a disagreement between the designer and the checker, the Project Manager is consulted. The Project Manager, if not technically qualified to resolve disagreement, will seek guidance from an appropriate technical expert to do so.

As a recommended best practice, checking of calculation sheets shall be performed on copies of the originals. They must be dated and signed on the cover page and signed or initialed on subsequent pages, then returned to the designer. At the point of agreement between the designer and the checker, original sheets shall be signed or initialed and dated. Electronic signature is acceptable if an acceptable method is established for the project. Calculation sheets shall be organized, indexed and kept in the permanent project file.

3.3.3.4 Reports

Reports include the following types of documents, which can comprise part of the project design deliverables:

- Design Basis Manual
- Geotechnical Report
- Supporting Calculations
- Feasibility Study

Reports should be completed following the policies and practices listed below:

- Report quality is primarily the responsibility of the Project Manager and lead engineer.
- Reports should be initiated from approved client or regulatory agency templates, whenever applicable, and/or internal Tetra Tech templates, and should comply with applicable Tetra Tech style guides.
- Report editing/word processing should be done only by personnel competent in the word processing software so as to maintain the integrity of the document formatting.
- Reports shall be reviewed and approved by senior level professionals.
- Reports shall be signed and sealed by licensed professionals as required.

In addition to technical accuracy and compliance with scope, reports are reviewed for clarity of wording, graphics standards, grammar/spelling, consistency, and overall document layout and presentation.

3.3.3.5 Contract Drawings

Contract documents consist primarily of contract drawings and specifications. Contract drawings include any engineering, architectural, or planning drawings prepared for a specific project. Specifications are discussed in the subsequent section. Contract drawings should be completed following the policies and practices listed below:

- Contract drawing quality standards should be consistent with client- or regulatory agency-specific guidelines or standards manuals.
- Drawing sets shall be well organized and arranged in a consistent format and order.
- Drawings shall be checked by the original designer after the calculations are checked. The checker should have a copy or access to final checked calculations.

- After drawing markups/comments are generated and the comments are addressed on the drawings, the markups/comments must be "back-checked" against the drawings to confirm that review comments have been addressed.

- Checking shall be performed on prints, which should be dated and signed; or through approved software specifically designed for drawing review. Drawing review software includes applications such as AutoDesk Design Review. When drawing review software is utilized, the process for naming and storing files and for the workflow associated with checking and back-checking should be included in the project QA/QC plan.

- Original sheets and electronic files shall be kept in the project files. Where practical and contractually permitted, prints should be scanned and stored electronically to minimize paper storage. The Project Manager establishes, in the UFP-QAPP and/or document control plan, the procedures for storing and naming files.

- Final design review prints/files shall be kept on file, at minimum, until construction of the project is completed and the project is commissioned, and/or placed in service under the owner's or operators control.

- Drawings shall be signed and sealed by licensed professionals as required.

Drawings must show the names (initials are acceptable) of the designer ("designed by") and the drafter ("drawn by") unless a client-specific title block excludes this information. If the drawing title block does not allow for recording of "designed by" and "drawn by" information then that information should be included in a non-printing area or layer of the drawing, or included as metadata to the drawing file. Drawings must be dated, sealed, and signed in accordance with the client's requirements.

Checking of drawings includes coordination with project specifications to avoid conflicts and/or unnecessary redundancy between drawings and specifications. All parties engaged in checking contract drawings should have a clear understanding as to the information that is intended to be included on the drawings and that which is intended to be included in specifications. Drawing reviewers must also be familiar with project cost and quantity estimates so that drawings can be verified against probable costs and estimated quantities.

Drawing reviews include considerations for constructability, operations, and maintenance, which should be performed by senior professionals with adequate field and/or construction experience. Drawing reviews include CAD standards and general graphic and presentation standards, which should be performed by senior designers familiar with the applicable standards for the project. Electronic CAD files should also be reviewed for adherence to CAD standards. When electronic deliverables are part of the contract scope, printed copies are not sufficient to review for adherence to CAD standards. Electronic review need not be performed on all drawings (unless a CAD standards checking software is utilized), but should be performed on a sufficient sampling of drawings to ensure that standards are being properly applied across all project disciplines. This review should include adherence to file naming and file organization standards. Keeping CAD files well organized and deleting or archiving obsolete files is a critical aspect of contract drawing quality. The Project Manager is responsible to ensure that sufficient review of electronic CAD files is occurring.

At a minimum, contract drawings shall be reviewed for completeness relative to project scope, adherence to applicable codes and standards, consistency and accuracy with design calculations and existing conditions, CAD standards, graphic presentation clarity, consistency across drawing set, constructability, operability, and maintainability at 30 percent, 60 percent, and 90 percent approximate levels of completeness.

3.3.3.6 Specifications

Specifications should be completed following the policies and practices listed below:

- The project specifications and/or drawings should clearly indicate how the specifications work in conjunction with the contract drawings.
- Specifications should be started from approved specification master templates – either those provided by the client or an approved Tetra Tech specification master. Care should be taken to ensure that each project is started using the most current master specification.
- Tetra Tech master specifications shall be periodically reviewed and updated to published industry specification standards, such as MasterSpec to ensure current references to codes, standards, etc.
- Specification editing shall be performed by, or edited under the direction of, senior level technical professionals or designated specification writers.
- Care should be taken to ensure that embedded information, such as notes to editors and specification selection options, is visible to those reviewing specifications so that the choices, instructions, explanations, etc. are visible to the specifications editor.
- Copies of the original specifications with markups (on printed copies or electronically) should be maintained in project files so that those reviewing edited project specifications can refer back to the original to review choices made, including additions and deletions.
- Specifications shall be signed and sealed by licensed professionals as required in the project state or province.

Because specification documents generally include sophisticated formatting, it is important that personnel experienced in specification editing, and in the word processing software (MS Word, etc.) prepare original specifications for preliminary project editing and perform the actual editing. Tetra Tech utilizes, on some projects, specification editing tools that facilitate the specification production process. These tools rely on the formatting styles, embedded field codes, hidden text, etc. to properly function; therefore, it is important to maintain the integrity and format of the electronic specification documents.

Reviews of specifications should be coordinated with other major reviews of contract drawings. Specifications should be reviewed to ensure that materials and work delineated on contract drawings are covered by the project specifications unless they are sufficiently specified on contract drawing notes. The reviews should ensure that drawings and specifications are well coordinated.

Specification reviews should include consideration of submittal requirements to ensure that contractors provide shop drawing and other required materials. These items will allow the client to have the product material needed for compilation of O&M manuals and for commissioning work.

3.3.3.7 Checking Reports, Drawings, and Specifications

Procedures for making review comments on reports, drawings, and specifications, and for back-checking those comments after they are addressed, shall be clearly delineated in the UFP-QAPP or other document control plan; and whenever possible shall follow established practices. This is particularly critical on large multi-disciplinary projects/tasks where numerous reviewers may comment on the same document. Examples of markup and back-check procedures include:

- Establishing color codes for each reviewer.

- Requiring yellow or pink highlighting of review comments after the comment has been addressed.

Establishing review checklists for use on the project is encouraged to ensure consistency of review comments and to clearly establish expectations for those performing design or writing reports and specifications. Project review checklists should be based on well-established checklists for specific disciplines or designs, modified for project ad client specific standards.

3.3.3.8 Using Appropriate Wording in Reports, Drawings, and Specifications

While the technical accuracy of reports, drawings, and specifications is very important, the language used to convey the technical information is also critical. Language that conveys the technical meaning, but may be interpreted in unintended ways, and have adverse legal consequences, should be avoided. Examples of good and bad practice include the following:

- Be instructive, not passive, in drawings and specifications. For example, a note on a site demolition plan pointing to an existing retaining wall indicating, "RETAINING WALL TO BE REMOVED" could be interpreted by the contractor as meaning it will be removed by someone else, when the intent is that the contractor include removal of the retaining wall in their bid. A more appropriate drawing note for this instruction is simply, "DEMOLISH AND REMOVE RETAINING WALL".

- Avoid wording that conveys a level of effort or diligence that is beyond industry standard of care or contract requirements. This includes inappropriate use of words such as "all," "every," and "always."

- Do not use terms like "inspect" or "approve" when Tetra Tech is only involved in design and CA. These terms should only be used when Tetra Tech's contract scope includes construction and/or construction management (CM) responsibilities. Instead, terms such as "observe" and "review" are more appropriate.

- Avoid terms such as "Draft" and "Final" when issuing documents and instead use terminology such as "Issued for Use" and "Issued for Review."

- When Tetra Tech's scope is limited to design and CA services, avoid words (and actions) that imply responsibility for jobsite safety, which are the responsibility of the contractor, not the design consultant.

3.3.3.9 Quantities and Cost Estimates (Opinions of Probable Cost)

Specifications, quantities, and cost estimates should be completed following the policies and practices listed below:

- The client's expectation of plus/minus accuracy for quantity and cost estimates should be understood so that those reviewing estimates ensure appropriate level of detail and that the level of contract document completeness is able to support the expected/desired level of accuracy in the estimate.

- All calculations of contract quantities shall be based on the contract documents and are treated in the same manner as design calculations.

- Estimates shall include adequate narratives, assumptions, and other documentation.

- Cost estimates performed during design must always be referred to as approximate – the term "Engineer's (or Architect's) Opinion of Cost" is a preferred terminology.

- Cost estimates shall be reviewed and approved by senior level design professionals.

3.3.3.10 Construction Administration

CA is essentially the continued involvement by the design consultant during project construction. CA is distinct from CM, which is discussed in this QMP in Section 3.4. When Tetra Tech performs CA, it generally means that Tetra Tech is not performing CM. When Tetra Tech is contracted to provide CM services, it may mean that Tetra Tech is directly responsible for CA (if design is also part of Tetra Tech's scope) or that CA is performed by a design subcontractor to Tetra Tech.

CA includes issuance of addenda, review of shop drawings and other forms of submittals by the construction contractor, answering RFIs, providing updated design information through ECNs, performing periodic site visits and issuing field observation reports, and performing punch lists at substantial completion and closeout. CA services should be completed following the policies and practices listed below:

- For addenda issued during the bidding process, the same review procedures that apply to contract drawings and specifications (addenda can apply to either) apply since an addendum represents an amendment to or correction of the contract documents.
- Copies of submittal reviews should be maintained in the project file.
- RFIs should be responded to by the original designer or designated CA representative. Responses must be reviewed and approved by the engineer of record for the affected documents before issuing to the client or construction contractor.
- Care should be taken when responding to RFIs that the responses are consistent with contract documents. If the RFI is requesting information already present in the contract documents, the RFI should be responded to by simply pointing the contractor to the relevant information in the contract drawings and/or specifications.
- The same procedures that apply to contract drawings and specifications apply to ECNs.
- The same procedures that apply to reports (Section 3.3.3.4) apply to field reports and punch lists.
- All reports shall be prepared using client or project standard report format.

Shop drawings and other submittals shall be reviewed for conformance to contract documents and stamped by Tetra Tech, but the construction contractor is still responsible for conformance with the contract documents unless specifically instructed by Tetra Tech to modify the design. Tetra Tech is responsible for providing a thorough and competent review of contractor submittals, but "approval" of these submittals does not de-obligate the contractor from constructing to contract document specifications unless specifically authorized to deviate.

Shop drawings often consist of assemblies involving multiple technical disciplines, such as HVAC equipment requiring electrical power. Shop drawing reviews are performed first by the responsible designer/engineer/architect for the primary discipline. They should also be reviewed and signed by the responsible parties in other affected disciplines. Shop drawings for multi-discipline assemblies can also affect individual shop drawings for other elements of the project. For example, an electrical engineer should see, and sign off on, the voltage/electrical characteristics for any equipment that is submitted to a mechanical engineer. Multiple reviews are important for coordination and review of other submittals that an electrical engineer will receive, such as wiring and control panels. Another example would be a concrete/rebar shop drawing for a mechanical equipment pad, which includes a bolt pattern for mechanical or electrical equipment mounted on the pad. Depending on which item is submitted for review first (the pad or the equipment), it is important that a structural

engineer engage the mechanical/electrical engineer or the mechanical/electrical engineer engage the structural engineer in the shop drawing review process.

Detailed review of shop drawings and other submittals should be performed by the original designer or by a shop drawing review specialist familiar with the contract documents. After detailed review, submittals, particularly those representing critical or complex aspects of the design, should be spot-checked by a senior level design professional, preferably the engineer or architect of record, before release to the construction contractor.

3.3.3.11 Record Drawings

Some contracts require record drawings, also known as "as-built" drawings, where contract drawings are updated to reflect any changes from the "approved for construction" contract drawings. The same procedures that apply to contract drawings (Section 3.3.3.5) apply to Record Drawings, plus the following:

- Even though it is common terminology, the term "as-built" should be avoided as this can imply confirmation of constructed conditions that is not practical or contractually required for the consultant.

The project files shall be reviewed to confirm that the contractor has provided a complete and orderly set of as-built data, per their contract obligations before proceeding with record drawings. It is generally the construction contractor's responsibility to maintain accurate records of changes from the "approved for construction" set of contract drawings.

Whenever possible and when feasible under contract terms, record drawings shall be verified through observations of field conditions.

3.3.3.12 O&M Manuals and Training

Designs involving industrial facilities and plant work, such as water or wastewater treatment facilities, often include an O&M manual and/or training component, where documentation and/or training is provided to the plant/facility operators. The following considerations and procedures should be applied:

- The purpose of an O&M manual is to provide the owner/operator with the information needed to understand the design criteria for the facility, operate the facility within the design parameters, maintain the equipment, troubleshoot effectively when issues arise, understand safety issues related to equipment and chemicals, and monitor the plant performance for compliance with functional and regulatory requirements. As such, the clarity and organization of the O&M material is extremely important.

- Assurance should be made that as-built information is in hand before finalizing O&M material. Product data, whether links to vendor sites or hard copies of data sheets, should be based on the actual final products installed in the field. Vendors should be consulted to ensure that referenced product data reflect proper O&M instructions for their products.

- Whenever possible, O&M and training material should be prepared and/or reviewed by staff with plant operation experience.

3.3.4 Records

The QA records generated by implementing this section of the QMP shall include the following:

- Checked calculations with applicable review and approval signatures

- Approved reports, drawings, specifications, and related design documents with applicable review signatures, including sealing of 100 percent design documents generated in support of design-engineered systems

3.4 Construction Management

3.4.1 Purpose and Scope

This section of the QMP establishes the quality policies and practices to ensure CM projects are performed under suitably controlled conditions according to the drawings, specifications, and requirements of the approved design. Note that CA, which is distinct from CM, is covered under Section 3.3 Design.

3.4.2 Responsibilities and Authorities

Tetra Tech management for CM projects is responsible for ensuring applicable QC activities are followed as per the requirements of this QMP and the approved designs. The Project Manager is responsible to ensure that CM projects are performed under suitably controlled conditions according to the requirements of the approved design.

The designated construction quality officer is responsible to ensure the requirements of this section of the QMP or other project-specific construction QC plans are properly applied. The designated construction quality officer has the authority to stop construction if he or she observes that quality or health and safety practices are not being followed correctly.

Personnel assigned to QC of construction projects are responsible for the following inspection activities:

- Developing written procedures for the inspection of items when standard specifications and drawings do not provide an adequate basis for inspection
- Preparing reports for inspections performed
- Controlling inspection procedures and revisions
- Scheduling and coordinating training for assigned QC personnel in advance of implementation of the applicable inspection documents

Personnel assigned to QC activities are responsible for performing inspection activities in accordance with the appropriate project design documents.

3.4.3 Requirements and Instructions

CM is the process of professional management applied to a planning, design, and construction project from inception to completion for the purpose of controlling time, scope, cost, and quality. This process applies integrated systems and procedures by a team of professionals to achieve the owner's project goals. These systems and procedures are intended to bring each team member's expertise to the project in an effective and meaningful manner. The essence of good CM is professionalism and teamwork, both within the CM firm and among the project team. The two primary components of the CM process are inspections and testing.

3.4.3.1 Inspections

Inspections are planned and executed at the project level to verify conformance of a project and its components to the specified requirements. In general, Tetra Tech considers construction inspection to be a part of the QC system in a project and inspections are described in project-

specific procedures that specify the characteristics subject to inspection and the inspection methods. Qualifications of inspection personnel are evaluated, approved, and documented in these procedures/plans. Inspector qualification records are maintained in project files in accordance with accepted procedures for document control.

Inspection documents are prepared based upon the quality requirements contained in purchasing documents, specifications, QC documents and procedures, work plans, QAPPs, compliance plans, risk mitigation documents, and other applicable codes and standards. Characteristics to be inspected, methods of inspection, and acceptance criteria must be identified during the inspection planning process. If mandatory inspection hold points are required, the specific hold points are indicated in the work control documents. Where mandatory inspection hold points are indicated on work control documents or procedures, work may continue beyond a hold point only with the written approval of the QC supervisor or designee. Work control documents shall specify or reference, at a minimum, the activities to be performed, the acceptance criteria, by whom the activities are performed, and the sequence in which the activities shall be performed. When inspections utilize a sampling program, the sampling plan is identified in the inspection documents. Sampling justification is based upon recognized standard construction practices and valid statistical methods; successful past experience; and the complexity and function of the activity, item, or service inspected.

Inspectors must have education, experience, and training to ensure their competence performing their assignment. Competence is developed by providing one or more of the following:

- Working knowledge of appropriate regulatory documents, practices, codes, and standards
- Training/orientation in planning and performing inspections
- On-the-job training under direct supervision of an experienced, qualified inspector
- The requirements for initial qualification of inspection personnel are based upon consideration of records of education and experience, test results, where applicable, and results of capability determination.

Personnel performing inspections shall maintain their proficiency through regular, active participation in the inspection process and/or review and study of codes, standards, and procedures related to QA programs and program inspection.

Inspection of items and facilities under construction or otherwise in-process are planned and executed at the project level in accordance with procurement documents, project work plans, and QAPP requirements. Indirect control by monitoring or surveillance of process controls, equipment, and/or personnel may be utilized if direct inspection is not possible, but the indirect controls must be specified in instructions or procedures.

Final inspections are executed at the project level and include records review, direct inspection (where possible), and review of resolution of nonconformances identified in prior inspections. Completed items are inspected in accordance with project-specified procedures for completeness, marking, calibrations, and any other characteristics required to verify the quality of the item and its conformance to the specifications. If an item is modified or repaired subsequent to its final inspection, re-inspection is required to verify continued conformance and acceptability for use.

3.4.3.2 Testing

Tests are required to demonstrate that items will perform satisfactorily in service and are identified and documented. Test requirements apply to all phases of a testing program, including but not limited to, functional testing, proof testing, acceptance testing, and operational testing. In general, Tetra Tech considers testing to be a part of the QC system in a project. Tests are described in

project-specific procedures that specify the characteristics subject to test, the test methods, and include or reference the acceptance limits contained in applicable technical documents.

Test procedures must include the following:

- Test configuration and objectives
- Use of trained personnel to witness and/or perform tests
- Identification of test equipment and the item to be tested
- Use of devices calibrated for the performance of tests
- Performance of tests under proper environmental conditions
- Documentation of test results
- Acceptance criteria for test requirements

Alternative procedures, such as ASTM methods or other consensus methods, may be used.

The Quality Lead, construction quality officer, or designee reviews project-specific test procedures for inclusion of the information noted in the above section. Test procedures may not be used until approved. Test results must be documented and evaluated by a designated, responsible individual to ensure that requirements and acceptance criteria have been satisfied. When tests are performed for design purposes, the results must be evaluated by the responsible design organization.

3.4.4 Records

Inspection records and documents shall be maintained in project files in accordance with accepted procedures for document control. Records of training, education, experience, and certification of inspectors shall be maintained for personnel who are performing inspections or who have previously performed inspections. These records shall be retained for the same period of time as that required for the inspection reports with which the inspection personnel are associated. Inspection records must indicate the item inspected the date of inspection, the type of observation, and whether or not the items or services inspected meet the applicable quality requirements. They must reference actions taken regarding nonconformances and must be signed by the inspector.

Records pertaining to testing shall be maintained in project files in accordance with accepted procedures for document control. Test reports shall be reviewed and signed in accordance with procedure requirements to ensure that test requirements have been satisfied.

3.5 Construction

3.5.1 Purpose and Scope

This section of the QMP establishes the quality policies and practices to ensure that construction, fabrication, manufacture, and erection of engineered systems are performed under suitably controlled conditions according to the drawings, specifications, and requirements of the approved design.

3.5.2 Responsibilities and Authorities

The Project Manager is responsible to ensure that construction, fabrication, manufacture, and erection of engineered systems are performed under suitably controlled conditions according to the requirements of the approved design. The Project Manager is also responsible for ensuring QA/QC

activities are implemented as per the requirements of this QMP, the approved design, and quality-related construction plans.

The designated construction quality officer is responsible to ensure the requirements of this section of the QMP or project-specific construction plans are properly implemented. The designated construction quality officer has the authority to stop construction if he or she observes that quality or health and safety practices are not being followed correctly.

3.5.3 Requirements and Instructions

The construction of engineered technologies shall be coordinated among applicable organizations, and includes the following requirements as applicable to the specific contract(s) performed:

- Projects are developed, assembled, and inspected in a controlled and managed order
- The plan for building/fabricating the project is being followed and that trained resources are assigned with clearly defined roles and responsibilities
- Measuring and monitoring devices used during fabrication are properly calibrated and certified
- Inspection plans are followed to verify compliance to design requirements

This policy applies to Tetra Tech tasks and operations with a construction component. It is applicable to mobilization, demolition, construction, testing, submittal, and commissioning activities during construction operations. Construction quality management encompasses all phases of work, such as submittals, procurement, storage of materials and equipment, coordination of subcontractor activities, and the inspections and tests required to ensure that the specified materials are used and the installation is acceptable to produce the required end product.

3.5.4 Records

The QA records generated by implementing this section of the QMP include the following:

- Records of acceptance of items and equipment used for the construction of engineered systems
- Traceability documents, when records of acceptance are maintained on documents traceable to an accepted item
- Startup, maintenance, and calibration records
- Documentation of final senior management and client approvals

3.6 Operation and Maintenance

3.6.1 Purpose and Scope

This section of the QMP establishes the quality policies and practices that shall be applied to systems that are operated and maintained by Tetra Tech. The policy is designed to ensure that such systems are operated and maintained according to management-approved designs, operating instructions, and guides. Any project-specific requirements shall be discussed in the UFP-QAPP and/or addenda, SOPs, or other quality related plans or procedures.

3.6.2 Responsibilities and Authorities

The Project Manager is responsible for ensuring that engineered environmental systems are operated according to management-approved design, operating instructions, and guides.

Tetra Tech personnel operating engineered technologies or performing support activities are responsible for controlling the quality of their activities and supervising system operators. All operators of engineered systems perform work processes and operations per the applicable requirements of the project-specific plans and procedures.

The Quality Lead is responsible for ensuring that the requirements of this section of the QMP are implemented.

3.6.3 Requirements and Instructions

The goal of QA during the O&M phase is to ensure the ability of a product to perform its intended function by invoking quantitative and qualitative analyses using system and equipment parameters to develop predictive performance models. The operation of engineered systems requires the development of procedures, work instructions, and/or SOPs for individuals to perform required operations. These procedures, work instructions, and SOPs are developed and controlled per the applicable requirements of Section 2.5 – Documents and Records.

Quality-related plans for O&M projects should address at least the following during the O&M life cycle:

- Development and integration of standardized, measurable/repeatable system monitoring to ensure performance requirements are fulfilled
- Design and implementation of quality- and reliability-centered maintenance plans to ensure product requirements are fulfilled and maintained
- Participation in system optimization activities and design reviews of operating system performance to achieve increased system effectiveness, operational availability, and lower maintenance costs
- Review and resolution of system performance anomalies including collaboration with suppliers and clients as necessary to establish effective, timely preventive/corrective-actions

The operation of engineered environmental systems is coordinated among participating organizations and shall include the following requirements as applicable to the specific task(s) performed:

- Only qualified and accepted services or items and consumables are used during the operation of systems.
- Status indicators with tolerance limitations must be provided to indicate the operating status of systems and components as indicated in the approved design and operating instructions.
- Identification of components and complete engineered systems are maintained or recorded in a manner ensuring that identification is accurately established and maintained.
- Inspections or tests are performed and documented at various points during operation to verify conformity to operating specification or parameters. Such inspections or tests clearly

indicate the acceptance criteria applied and reflect the importance of the item or service to quality.

- The handling, storing, cleaning, and preservation of equipment, components, and complete engineered systems are controlled during setup and operation to prevent damage, loss, and deterioration.

- Periodic preventive and corrective maintenance of engineered systems is performed and documented according to operating guidance and/or design specifications to ensure satisfactory performance of the system within established operating parameters.

- Critical spare parts are provided and maintained according to operating guidance and/or design specifications.

- All measurement and testing equipment affecting quality are of the proper type, range, and accuracy and are calibrated, maintained, and used according to approved design specifications.

- Equipment found unsatisfactory for acceptance testing must be recalibrated and certified within tolerances or replaced. The validity of any measurements and tests performed with out-of-calibration equipment is evaluated and such measurements and tests are repeated as required.

3.6.4 Records

The QA records generated by implementing this section of the QMP shall include the following:

- Acceptance records for startup and operation of components, equipment, and complete engineered systems

- Logs and other documentation of the O&M of systems and their components including review and sign-off by project management and/or quality team personnel

- Calibration records

3.7 Commissioning and/or Verification and Acceptance of Systems

3.7.1 Purpose and Scope

This section of the QMP establishes the quality policies and practices that shall be applied to construction inspection and operational acceptance testing of engineered systems and their components. Construction inspection and operational acceptance tasks are performed according to specified approved design specifications and operating documents. Project-specific requirements are discussed in individual quality-related plans. For ease of discussion the term “commissioning” is used in this section to refer to “verification and acceptance of systems.”

3.7.2 Responsibilities and Authorities

The Project Manager is responsible for ensuring that engineered systems are properly inspected and tested and that appropriate submittals and information are specified in the contract documents obtained during construction to facilitate commissioning work. Inspection and testing of temporary facilities are performed as determined by the design engineer.

Managers, personnel inspecting or testing engineered systems, or personnel performing support activities are responsible for documenting the outcome of inspection and testing related activities.

All operators of engineered systems perform work processes and operations per the applicable requirements of the project-specific plans and procedures.

The Quality Lead is responsible for ensuring that the requirements of this section of the QMP are properly implemented.

3.7.3 Requirements and Instructions

The inspection and testing of construction and operation of engineered systems requires the development of procedures, inspection plans, test plans, and/or SOPs for individuals to perform required tasks. Commissioning of systems does not begin after construction, but is an integral part of the design and construction phases when key submittal and pre-commissioning requirements, which are critical to inspection and testing, are specified and verified.

Development of procedures is coordinated among participating organizations and shall include the following requirements, as necessary, for the specific task(s) to be performed:

- Specifications are reviewed to ensure that submittal and pre-commissioning requirements are appropriately specified in the contract documents for commissioning work.

- A specification section, such as "Starting of Systems," shall be included that clearly identifies the contractor's pre-commissioning and commissioning responsibilities. This should include requirements for master O&M training schedule, substantial completion submittal -- including items such as O&M manuals, equipment installation and pre-demonstration start-up certifications, as well as proof of receipt of specified items from manufacturers or suppliers -- and provisions for the cost of startup activities.

- Startup specifications and test plans should, at minimum, identify requirements for a pre-demonstration period; a demonstration period; personnel training; testing, adjusting, and balancing; and requirements for related systems. Schedule requirements for startup, verification, and acceptance should be clearly defined.

- Contract specifications should clearly identify the actions required by the construction contractor when systems or components do not meet performance specifications.

- Pre-commissioning requirements by the construction contractor or vendors as described shall be verified before performing final commissioning activities.

- Testing plans are developed to ensure key system performance requirements have been met. Testing plans are reviewed by experienced engineers and/or operators to ensure that the plans include proper procedures, safeguards, checklists, etc. to avoid damage to systems during testing and verification. Plans should include validation of measurement equipment to ensure that testing is grounded on accurate measurement of system performance.

- Testing of systems should not begin until the performance and operability of individual system components have been verified and documented.

- Testing is conducted by qualified and trained personnel with clearly defined roles and responsibilities.

- Test results are analyzed for conformance to expected system performance and any non-conformances are documented. Non-conformance documentation is reviewed to ensure that corrective requirements are clearly identified and in line with contract documents and performance requirements.

3.7.4 Records

The QA records generated by implementing the requirements of this section of the QMP include the following:

- Copy of approved procedures and test plans
- Documents indicating acceptance or rejection of either inspection and testing or re-inspection and retesting
- Equipment startup certificates and calibration records